Cover/Frequency (CF)
Sampling Method

EXECUTIVE SUMMARY

The FIREMON Cover/Frequency (CF) method is used to assess changes in plant species cover and frequency for a macroplot. This method uses multiple quadrats to sample within plot variation and quantify statistically valid changes in plant species cover, height, and frequency over time. Since it is difficult to estimate cover in quadrats for larger plants, this method is primarily suited for grasses, forbs, and shrubs less than 3 feet (1 m) in height. Quadrats are placed systematically along randomly located transects. Cover is assessed by visually estimating the percent of a quadrat occupied by the vertical projection of vegetation onto the ground. Plant species frequency is recorded as the number of times a species occurs within a given number of quadrats. Frequency is typically recorded for plant species that are rooted within the quadrat.

INTRODUCTION

The Cover/Frequency (CF) method is designed to sample within plot variation and quantify changes in plant species cover, height, and frequency over time. This method uses quadrats that are systematically placed along transects located within the macroplot. First, a baseline is established along the width of the plot. Transects are oriented perpendicular to the baseline and are placed at random starting points along the baseline. Quadrats are then placed systematically along each transect. Characteristics are recorded about the general CF sample design and for individual plant species within each quadrat. First the transect length, number of transects, quadrat size, and number of quadrats per transect are recorded. Within each quadrat, depending on the project objectives, any combination of cover, frequency, and height are recorded for each plant species.

This method is primarily used when the manager wants to monitor statistically significant changes in plant species cover, height, and frequency. The CF sampling method is most appropriate for vascular and non-vascular plants less than 3 feet (1 m) in height. The FIREMON line intercept (LI) method is better suited for estimating cover of shrubs greater than 3 feet (1 m) in height (e.g. western U.S. shrub communities, mixed plant communities of grasses, trees, and shrubs, and open grown woody vegetation). The CF methods can also be used to estimate ground cover, however, the FIREMON point intercept (PO) methods are better suited for estimating ground cover. We suggest you use the PO method if you are primarily interested in monitoring changes in ground cover. The PO method may be used in conjunction with the CF method to sample ground cover by using the CF sampling quadrat as a point frame. The PO method is also better suited for sampling fine textured herbaceous communities (e.g. dense grasslands and wet meadows). However, if rare plant species are of interest the CF methods are preferred since it is easier to sample rare species with quadrats than with points or lines.

Estimating Cover and Height

Cover is an important vegetation attribute which is used to determine the relative influence of each species on a plant community. Cover is a commonly measured attribute of plant community composition because small, abundant species and large, rare species have comparable cover values. In FIREMON we record foliar cover as the vertical projection of the foliage and supporting parts onto the ground. Therefore, total cover on a plot can exceed 100 percent due to overlapping layers in the canopy.

Estimating cover in quadrats is more accurate than estimating cover on a macroplot because samplers record cover in small quadrats more consistently than in large areas. Sampling with quadrats is also more effective than the point intercept (PO) method at locating and recording rare species. Point intercept sampling requires many points to sample rare species (e.g. 200 points to sample at 0.5 percent cover). Quadrats sample more area and have a greater chance of detecting rare species.

Cover is typically based on a visual estimate of cover classes that range from 0 to 100 percent. These classes are broadly defined, lowering the chance for consistent human error in assigning the cover class. The lowest cover classes are sometimes split into finer units, since many species fall into the lowest cover classes. These systems are more sensitive to species with low cover. A finer breakdown of scale toward the lower scale values allows better estimation of less abundant species. In FIREMON we use a cover class system, which splits the lowest classes into finer units. The midpoint of each class can be used for numerical computations. The use of midpoints for actual values is based on the assumption that actual cover values are distributed symmetrically about the midpoint.

Plant height measurements are used to estimate the average height of individual plant species. Plant heights give detailed information about the vertical distribution of plant species cover on the plot. In addition, height measurements allow the examiner to calculate plant species volume (cover x height) and to estimate biomass using the appropriate bulk density equations. Plant height is measured with a yardstick (meter stick) for plants less than 10 feet tall (3 m) and with a clinometer and tape measure for taller plants.

Estimating Frequency

Frequency is used to describe the abundance and distribution of species and can be used detect changes in vegetation over time. It is typically defined as the number of times a species occurs in the total number of quadrats sampled, usually expressed as a percent. Frequency is one of the fastest and easiest methods for monitoring vegetation because it is objective, repeatable and requires just one decision: whether or not a species is rooted within the quadrat frame. Frequency is a useful tool for comparing two plant communities or to detect change within one plant community over time.

Frequency is most commonly measured with square quadrats. The size and shape of the frequency quadrat influences the results of the frequency recorded. If a plot is too small, rare plants may not be recorded. If you use a large quadrat, you will have individual species in all quadrats and frequency values of 100 percent which will not allow you to track increases in frequency. If you have small quadrats, you will record low frequency values which are not very sensitive to declining frequency values for a species. A reasonable sensitivity to change results from frequency values between 20 to 80 percent. Frequencies less than 5 percent or greater than 95 percent typically result in heavily skewed distributions.

For this reason, nested plots, or subplots, are usually used to sample frequency. Plot sizes are nested in a configuration that gives frequencies between 20 and 80 percent for the majority of species. Nested subplots allow frequency data to be collected in different size subplots of the main quadrat. Since frequency of occurrence can be analyzed for different sized plots, this eliminates the problems of comparing data collected from different size quadrats. In FIREMON, we use a nested plot design of four subplots within one quadrat, and record the smallest subplot number in which the plant is rooted. This frequency measurement is typically referred to as nested rooted frequency (NRF).

Since plant species frequency is highly sensitive to the size and shape of quadrats, changes in frequency can be difficult to interpret, possibly resulting from changes in cover, density, or pattern of distribution. For this reason, if money and time are available we recommend you collect cover data along with frequency data. However, if you are only concerned about documenting that a change in vegetation has occurred, then frequency is the most rapid method.

There are many ways to streamline or customize the CF sampling method. The FIREMON three-tier sampling design can be employed to optimize sampling efficiency. See the sections on **User Specific CF Sampling Design** and **Sampling Design Customization** below.

SAMPLING PROCEDURE

This method assumes that the sampling strategy has already been selected and the macroplot has already been located. If this is not the case, then refer to the FIREMON **Integrated Sampling Strategy** and for further details.

The sampling procedure is described in the order of the fields that need to be completed on the CF data form, so it is best to reference the data form when reading this section. The sampling procedure described here is the recommended procedure for this method. Later sections will describe how the FIREMON three-tier sampling design can be used to modify the recommended procedure to match resources, funding, and time constraints.

See **How To Locate a FIREMON Plot**, **How To Permanently Establish a FIREMON Plot** and **How to Define the Boundaries of a Macroplot** for more information on setting up your macroplot.

Preliminary Sampling Tasks

Before setting out for your field sampling, layout a practice area with easy access. Try and locate an area with the same species or vegetation lifeform you plan on sampling. Get familiar with the plot layout and the data that will be collected. This will give you a chance to assess the method and will help you think about problems that might be encountered in the field. For example, how will you account for boundary plants? It is better to answer these questions before the sampling begins so that you are not wasting time in the field. This will also let you see if there are any pieces of equipment that will need to be ordered.

A number of preparations must be made before proceeding into the field for CF sampling. First, all equipment and supplies in the **CF Equipment List** must be purchased and packed for transport into the field. Since travel to FIREMON plots is usually by foot, it is important that supplies and equipment be placed in a comfortable daypack or backpack. It is also important that there be spares of each piece of equipment so that an entire day of sampling is not lost when something breaks. Spare equipment can be stored in the vehicle rather than the backpack. Be sure all equipment is well maintained and there are plenty of extra supplies such as plot forms, map cases, and pencils.

All CF data forms should be copied onto waterproof paper because inclement weather can easily destroy valuable data recorded on standard copier paper. Plot forms should be transported into the field using a plastic, waterproof map protector or plastic bag. The day's sample forms should always be stored in a dry place (i.e., office or vehicle) and not be taken back into the field for the next day's sampling.

We recommend that one person on the field crew, preferably the crew boss, have a waterproof, lined field notebook for recording logistic and procedural problems encountered during sampling. This helps with future re-measurements and future field campaigns. All comments and details not documented in the FIREMON sampling methods should be written in this notebook. For example, snow on the plot might be described in the notebook, which would be very helpful in plot re-measurement.

Plot locations and/or directions should be readily available and provided to the crews in a timely fashion. It is beneficial to have plot locations for several days of work in advance in case something happens, such as the road to one set of plots is washed out by flooding. Plots should be referenced on maps and aerial photos using pin-pricks or dots to make navigation easy for the crew and to provide a check of the georeferenced coordinates. If possible, the spatial coordinates should be provided if FIREMON plots were randomly located.

A field crew of two people is probably the most efficient for implementation of the CF sampling method. There should never be a one-person field crew for safety reasons, and any more than two people will probably result in part of the crew waiting for tasks to be completed and unnecessary trampling on the FIREMON macroplot. The crew boss is responsible for all sampling logistics including the vehicle, plot directions, equipment, supplies, and safety. The crew boss should be the note taker and the technician should perform most quadrat measurements. The initial sampling tasks of the field crew should be assigned based on field experience, physical capacity, and sampling efficiency. As the field crew gains experience switch tasks so that the entire crew is familiar with the different sampling responsibilities and to limit monotony.

Designing the CF Sampling Method

There is a set of general criteria recorded on the CF Plot form that forms the user-specified design of the CF sampling method. Each general CF field must be designed so that the sampling captures the information needed to successfully complete the management objective within time, money and personnel constraints. These general fields should be determined before the crews go into the field and should reflect a thoughtful analysis of the expected problems and challenges in the fire monitoring project.

Plot ID construction

A unique plot identifier must be entered on the CF data form. This is the same plot identifier used to describe general plot characteristics in the Plot Description or PD sampling method. Details on constructing a unique plot identifier are discussed in the **How to Construct a Unique Plot Identifier** section. Enter the plot identifier at the top of the CF data form.

Determining the Sample Size

The size of the macroplot ultimately determines the length of the transects and the length of the baseline along which the transects are placed. The amount of variability in plant species composition and distribution determines the number and length of transects and the number of quadrats required for sampling. The typical macroplot sampled in the CF method is a 0.10 acre (0.04 ha) square measuring 66 x 66 feet (20 x 20 m), which is sufficient for most forest understory and grassland monitoring applications. Shrub dominated ecosystems will generally require larger macroplots when sampling with the CF method. Dr. Rick Miller has sampled extensively in shrub dominated systems and we have included a write-up of his method in **Appendix C: Rick Miller Method for Sampling Shrub Dominated Systems**. If you are not sure of the plot size to use contact someone that as sampled the same vegetation that you will be sampling. The size of the macroplot may be adjusted to accommodate different numbers and lengths of transects. In general it is more efficient if you use the same plot size for all FIREMON sampling methods on the plot, however we recognize that this is not always feasible.

We recommend sampling five transects within the macroplot, and this should be sufficient for most studies. However, there are situations when more transects should be sampled. See **How To Determine Sample Size** for more details. Enter the number of transects in Field 1 on the CF data form. The recommended transect length is 66 feet (20 m) for a 66 x 66 feet (20 x 20 m) macroplot. However, the macroplot size may be adjusted to accommodate longer or shorter transects based on the variability in plant species composition and distribution. For example, transects may be lengthened to accommodate more quadrats per transect or to allow more distance between quadrats. Enter the transect length in Field 2 of the CF data form. The FIREMON CF data form and data entry screen allow an unlimited number of transects.

We recommend sampling at least five quadrats per transect, and this should be sufficient for most studies. However, there are situations when more quadrats should be sampled. Additional quadrats may be sampled by placing more quadrats along a transect or by sampling more transects within the macroplot. See **How To Determine Sample Size** for more details. Enter the number of quadrats per transect in Field 3 of the CF data form. The FIREMON CF data form and data entry screen allow up to 25 quadrats per transect.

Determining the Quadrat Size

Frequency is typically recorded in square quadrats. The standard quadrat for measuring nested rooted frequency in a 20 x 20 inch (50 x 50 cm) square with four nested subplot sizes. A nested frame allows frequency data to be collected in different size subplots of the main quadrat. Measuring frequency this way is commonly referred to as nested rooted frequency (NRF). Plot sizes are nested in a configuration that gives frequencies between 20 to 80 percent for the majority of species. Tables CF-1 and CF-2 list common quadrat and subplot sizes in English and metric dimensions for recording nested rooted frequency. See **How To Construct a Quadrat Frame** for instructions on building and using quadrat frames. Cover can be estimated using the same quadrat frames and recorded at the same time frequency is recorded.

Table CF-1. Commonly used quadrat sizes for recording nested rooted frequency (english dimensions).

NRF Numbers	Standard	Grassland Communities	Sagebrush Communities	Pinyon-Juniper
Subplot 1	2 x 2 in.	-------	2 x 2 in.	-------
Subplot 2	10 x 10 in.	2 x 2 in.	4 x 4 in.	8 x 8 in.
Subplot 3	10 x 20 in.	4 x 4 in.	8 x 8 in.	20 x 20 in.
Subplot 4	20 x 20 in.	8 x 8 in.	20 x 20 in.	40 x 40 in.

Table CF-2. Commonly used quadrat sizes for recording nested rooted frequency (metric dimensions).

NRF Numbers	Standard	Grassland Communities	Sagebrush Communities	Pinyon-Juniper
Subplot 1	5 x 5 cm	-------	5 x 5 cm	-------
Subplot 2	25 x 25 cm	5 x 5 cm	10 x 10 cm	20 x 20 cm
Subplot 3	25 x 50 cm	10 x 10 cm	20 x 20 cm	50 x 50 cm
Subplot 4	50 x 50 cm	20 x 20 cm	50 x 50 cm	100 x 100 cm

Enter the quadrat length (Field 4) and quadrat width (Field 5) in inches (cm) on the CF data form.

Recording the Subplot Size Ratio and NRF Numbers

If nested rooted frequency is being recorded, then enter the percent area of the quadrat contained by each subplot in Field 6 on the CF data form. Start with the smallest subplot and end with the largest subplot. For example, the subplot ratio for the standard 20 x 20 inch (50 x 50 cm) quadrat would be 1:25:50:100. Subplot 1 is 2 x 2 inches (5 x 5 cm) and is 1 percent of the quadrat. Subplot 2 is 10 x 10 inches (25 x 25 cm) and is 25 percent of the quadrat. Subplots 3 and 4 are 10 x 20 inches (25 x 50 cm) and 20 x 20 inches (50 x 50 cm), which correspond to 50 and 100 percent of the quadrat, respectively. See **How To Construct a Quadrat Frame** for more details about subplot sizes.

If nested rooted frequency is being recorded, then enter the corresponding frequency numbers for each subplot in Field 7 of the CF data form. Start numbering with the smallest subplot and end with the largest subplot. For example, 1:2:3:4 would correspond with the 1:25:50:100 percentages of total plot when using the standard 20 x 20 inch (50 x 50 cm) quadrat.

Conducting CF Sampling Tasks

Establishing the baseline for transects

Once the plot has been monumented, a permanent baseline is set up as a reference from which you will orient all transects. The baseline should be established so that the sampling plots for tall of the methods overlap as much as possible. See **How To Establish Plots with Multiple Methods**. The recommended baseline is 66 feet (20 m) long and is oriented upslope with the 0-foot (0 m) mark at the lower permanent marker and the 66-foot (20 m) mark at the upper marker. On flat areas, the baseline runs from south to north with the 0-foot (0 m) mark on the south end and the 66-foot (20 m) mark on the north end. Transects are placed perpendicular to the baseline and are sampled starting at the baseline. On flat areas, transects are located from the baseline to the east. See **How To Establish a Baseline for Transects** for more details.

Locating the Transects

Locate transects within the macroplot perpendicular to the baseline and parallel with the slope. For permanent plots, determine the compass bearing of each transect and record these on the plot layout map or the comment section of the PD form. Permanently mark the beginning and ending of each transect (for example, using concrete reinforcing bar). Starting locations for each transect can be determined randomly on every plot or systematically with the same start locations used on every plot in the project. In successive re-measurement years, it is essential that transects be placed in the same locations as in previous visits. If the CF method is used in conjunction with other replicated sampling methods (LI, PO, RS or DE), use the same transects for all methods, whenever possible. See **How To Locate Transects and Quadrats** for more details.

Locating the Quadrats

We recommend sampling five quadrats located at 12 foot (4 m) intervals along a transect, with the first quadrat placed 12 feet (4 m) from the baseline. See **How To Locate Transects and Quadrats** for more details. If macroplots are being sampled for permanent remeasurement, quadrats must be placed at specified intervals along a measuring tape, which is placed along each, transect. In successive years for remeasurement, quadrats *must* be placed in the same location. When sampling macroplots that are not scheduled for permanent remeasurement, the distance between quadrats may be estimated by pacing after the examiner measures the distance between quadrats.

Each quadrat is placed on the uphill side of the transect line with quadrat frame placed parallel to the transect. The lower left corner of the quadrat frame will be placed at the foot (meter) mark for the quadrat location. Figure CF-1 displays the proper placement of a quadrat frame.

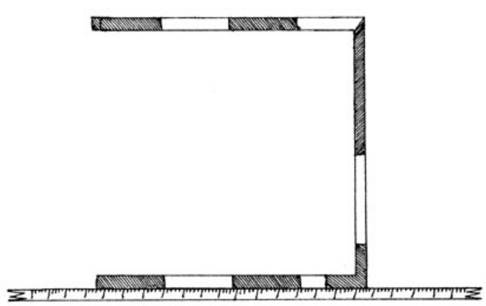

Figure CF-1. An example of quadrat placement along a transect.

Quadrat Sampling

First, enter the transect number which is being sampled in Field 8 of the CF plot form. Next, enter the plant species or item code in Field 9. FIREMON uses the NRCS Plants species codes, however you may use your own species codes. See **How to Customize Plant Species Codes** for more details. If ground cover is being sampled, we recommend using the ground cover codes listed in table CF-3.

Table CF-3. FIREMON Ground Cover Codes

Ground Cover Code	Ground Cover Description	Ground Cover Code	Ground Cover Description
ASH	Ash (organic, from fire)	LICH	Lichen
BAFO	Basal forb	LITT	Litter and Duff
BAGR	Basal graminoid	MEGR	Medium gravel (5-20 mm)
BARE	Bare soil (soil particles < 2 mm)	MOSS	Moss
BARR	Barren	PAVE	Pavement
BASH	Basal shrub	PEIC	Permanent Ice
BATR	Basal tree	PEIS	Permanent Ice and Snow
BAVE	Basal vegetation	PESN	Permanent Snow
BEDR	Bedrock	ROAD	Road
BOUL	Boulders (round and flat)	ROBO	Round boulder (> 600 mm)
CHAN	Channers (2-150 mm long)	ROCK	Rock
CHAR	Char	ROST	Round stone (250-600 mm)
CML	Cryptogams, mosses and lichens	STON	Stones (Round and flat)
COBB	Cobbles (75-250 mm)	TEPH	Tephra volcanic
COGR	Coarse gravel (20-75 mm)	TRIC	Transient Ice
CRYP	Cryptogamic Crust	TRIS	Transient Ice and Snow
DEVP	Developed Land	TRSN	Transient Snow
FIGR	Fine gravel (2-5 mm)	UNKN	Unknown
FLAG	Flag stones (150-380 mm long)	WATE	Water
FLBO	Flat boulders (>600 mm long)	WOOD	Wood
FLST	Flat Stone (380-600mm long)	X	Not Assessed
GRAV	Gravel (2-75 mm)		

Next enter the plant species status in Field 10 on the CF data form. Status describes the general health of the plant species as live or dead using the following codes:

L – Live: plant with living tissue
D – Dead: plant with no living tissue visible
NA – Not Applicable

Plant status is purely qualitative but it does provide an adequate characteristic for stratification of pre-burn plant health and in determining post-burn survival. Be careful when making this assessment on plant in their dormant season.

Cover

Cover is the vertical projection of the vegetation foliage and supporting parts onto the ground (figure CF-2). Estimating cover within quadrats is made easier by using subplot sizes and the percent of quadrat area they represent (figure CF-3). Subplots are used to estimate cover for a plant species by mentally grouping cover for all individuals of a plant species into one of the subplots. The percent size of that subplot, in relation to the size of the quadrat being sampled, is used to make a cover class estimate for the species. See **How to Estimate Cover** for more details.

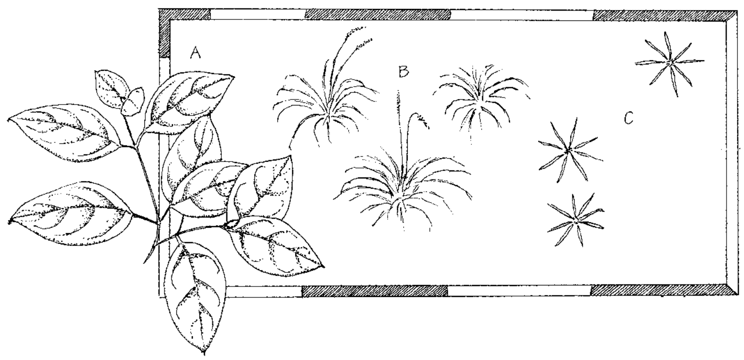

Figure CF-2. Cover from species A is estimated even though this species is not actually rooted within the quadrat.

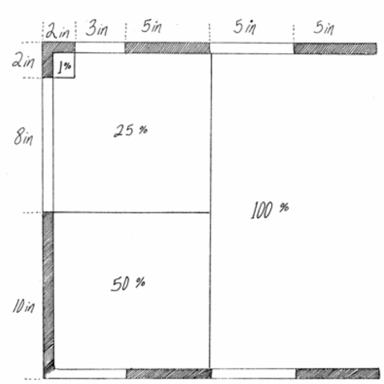

Figure CF-3. Subplot dimensions and respective percent of the total plot. Subplots aid the sampler in estimating cover by mentally grouping cover for all individuals of a plant species into one of the subplots.

For each plant species or ground cover class in the quadrat, estimate its percent cover within the quadrat and enter a cover class code (table CF-4) to denote that value. Enter the cover class for each quadrat.

Table CF-4. FIREMON Cover Class Codes.

Code	Cover Class
0	Zero percent cover
0.5	>0-1 percent cover
3	>1-5 percent cover
10	>5-15 percent cover
20	>15-25 percent cover
30	>25-35 percent cover
40	>35-45 percent cover
50	>45-55 percent cover
60	>55-65 percent cover
70	>65-75 percent cover
80	>75-85 percent cover
90	>85-95 percent cover
98	>95-100 percent cover

Nested Rooted Frequency

The standard 20 x 20 inch (50 x 50 cm) quadrat is partitioned into four subplots for recording nested rooted frequency (figure CF-4 and table CF-5). Species located in the smallest subplot are given the frequency value of 1. Plants in successively larger subplots have frequency values of 2, 3 and 4. Decisions about counting boundary plants, plants that have a portion of basal vegetation intersecting the quadrat, need to be applied systematically to each quadrat. See **How to Count Boundary Plants** for more details.

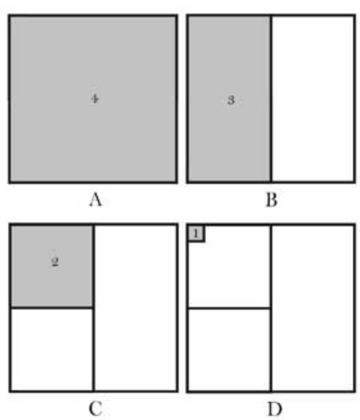

Figure CF-4. The numbers inside the plot frame denote the value recorded if a plant is present in that area of the frame. The number 4 corresponds to the entire quadrat (A). The sampling area for number 3 is the entire top half of the quadrat (B). The sampling areas for the numbers 2 and 1 are the upper left quarter and the upper left corner (1%) of the quadrat, respectively (C and D). Each larger subplot contains all smaller subplots. Subplots aid the sampler in estimating cover by mentally grouping cover for all individuals of a plant species into one of the subplots.

Table CF-5. Percent of quadrat represented by the four subplots used to record nested rooted frequency within the standard 20 x 20 in. (50 x 50 cm) quadrat.

Subplot Number for Rooted Frequency	**Size of Subplot**	**Percent area of a 20 x 20 in. (50 x 50 cm) Quadrat**
1	2 x 2 in. (5 x 5 cm)	1 percent
2	10 x 10 in. (25 x 25 cm)	25 percent
3	10 x 20 in. (25 x 50 cm)	50 percent
4	20 x 20 in. (50 x 50 cm)	100 percent

Record the smallest size subplot in which each plant species is rooted (figure CF-5 and table CF-6). Begin with subplot 1, the smallest subplot. If the basal portion of a plant species is rooted in that subplot, record 1 for the species. Next find all plant species rooted in subplot 2, which were not previously recorded for subplot 1, and record a 2 for these plant species. Then identify all plant species, which are rooted in subplot 3, which were not previously recorded for subplots 2 and 1, and record a 3 for these species. Finally, record a 4 for each species rooted in subplot 4, the remaining half of the quadrat, which were not previously recorded in subplots 3, 2, and 1. Enter the subplot number in the NRF field for each species on the CF data form.

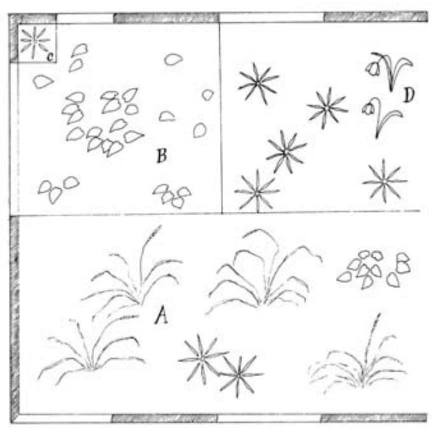

Figure CF-5. Example of recording nested rooted frequency values for plant species in a 20 x 20 inch (50 x 50 cm) quadrat frame. Table CF-6 lists the nested rooted frequency value for each plant species displayed in this figure.

Table CF-6. Standard NRF frame subplot sizes and NRF numbers for the plants illustrated in figure CF-5.

Species Symbol	**Smallest Subplot Size in which Species is Rooted**	**NRF Value**
C	Smallest, 2 x 2 in. (5 x 5 cm)	1
B	Next largest,10 x 10 in. (25 x 25 cm)	2
D	Next largest, 10 x 20 in. (25 x 50 cm)	3
A	Largest, 20 x 20 in. (50 x 50 cm)	4

Estimating Height

Measure the average height for each plant species in feet (meters) within +/- 10 percent of the mean plant height. See **How to Measure Plant Height** for more details. Enter plant height in the Height field for each quadrat.

Precision Standards

Use these precision standards for the CF sampling.

Table CF-7. Precision guidelines for CF sampling.

Component	Standard
Cover	± 1 class
NRF	No error
Height	± 10 percent

SAMPLING DESIGN CUSTOMIZATION

This section will present several ways that the CF sampling method can be modified to collect more detailed information or streamlined to collect basic information. First, the suggested or recommended sample design is detailed, then modifications are presented.

Recommended CF Sampling Design

The recommended CF sampling design follows the Recommended FIREMON Sampling Strategy and is listed below:

Measure only plant species cover and nested rooted frequency within each quadrat.

Macroplot Size: 0.1 acre, 66 ft x 66 ft. (400 square meters, 20 x 20 m)
Quadrat Size: 20 x 20 in. (50 x 50 cm)
Number of Transects: 5
Number of Quadrats / Transect: 5

The quadrat size should be adjusted according to the plant community being sampled.

The number of transects and quadrats sampled should be adjusted according to the appropriate methods in the "How To" section of the FIREMON manual.

Streamlined CF Sampling Design

The streamlined CF sampling design follows the Simple FIREMON sample strategy and is designed below:

Measure only nested rooted frequency within each quadrat.

Macroplot Size: 0.1 acre, 66ft x 66ft. (400 square meters, 20 x 20 m)
Quadrat Size: 20 x 20 in. (50 x 50 cm)
Number of Transects: 5
Number of Quadrats / Transect: 5

The quadrat size should be adjusted according to the plant community being sampled.

The number of transects and quadrats sampled should be adjusted according to the appropriate methods in the "How To" section of the FIREMON manual.

Comprehensive CF Sampling Design

The comprehensive CF sampling design follows the Detailed FIREMON sampling strategy and is detailed below:

Measure plant species cover , nested rooted frequency, and average plant species height within each quadrat.

Macroplot Size: 0.1 acre, 66ft x 66ft. (400 square meters, 20 x 20 m)
Quadrat Size: 20 x 20 in. (50 x 50 cm)
Number of Transects: 5
Number of Quadrats / Transect: 5

The quadrat size should be adjusted according to the plant community being sampled.

The number of transects and quadrats sampled should be adjusted according to the appropriate methods in the "How To" section of the FIREMON manual.

User-specific CF Sampling Design

There are many ways the user can modify the CF sample fields to make sampling more efficient and meaningful for local situations. Examiners may adjust the number of transects, transect length, and number of quadrats as needed for the specific task.

Quadrat sizes other than the standard 20 x 20 n. (50 x 50 cm) frame can be used for sampling. Small, 4 x 4 in (10 x 10 cm), quadrats can be used in dense wet meadow communities and large, 40 x 40 in. (1 x 1 m), quadrats can be used in sparse or large vegetation (e.g., shrub communities). Nested subplots are not needed when sampling rooted frequency when the plant species being sampled have similar distribution and abundance within the macroplot. Plant species frequency may simply be recorded as presence within the quadrat. The FIREMON sampling forms and databases will accommodate most sampling variations of the recommended procedure.

Ocular estimates of cover can be recorded to the nearest 1 percent (i.e., 17%) instead of a cover class. This will allow values to be grouped into different cover classes later when conducting data analysis. Since not all examiners use the same cover classes, this allows the actual estimated cover values to be grouped into any cover class convention. However, it is doubtful that cover can be accurately estimated to a 1% level using the human eye. If actual cover values are recorded, or if different cover classes are used than the classes listed in the FIREMON CF methods, record this information with the Metadata (MD) method.

Sampling Hints and Techniques

Examiners must be able to identify many plant species and be able to determine whether a plant species occurs within a quadrat. Examiners must also be familiar with the cover classes used to estimate cover. When collecting rooted frequency data, herbaceous plants (grasses and forbs) must be rooted within the quadrat. However, on many occasions trees and shrubs rooted within the quadrat will provide an inadequate sample size. Counting plants whose canopy overhangs the quadrat may increase tree and shrub sample size.

Examiners can calibrate their eyes for estimating cover by using the various subplots within a quadrat frame. Examiners should become familiar with all the subplot sizes and the percent of the entire quadrat each subplot represents. Species are mentally grouped into a subplot and the subplot size is used to estimate percent cover. See **How to Estimate Cover** for more details.

Measuring tapes come in a variety of lengths, increments, and materials. Examiners should choose tapes with the appropriate units and at least as long, or a little longer, than the transect length being sampled. Since, steel tapes do not stretch they are the most accurate over long remeasurement intervals. Steel is probably the best choice for permanent transects where remeasurement in exactly the same place each time is important. Cloth and fiberglass tapes will stretch over the life of the tape, but are easier to use than steel tapes since they are lighter and do not tend to kink.

The sampling crew may encounter an obstacle, such as a large rock or tree, along one of the transect lines that interferes with the quadrat sampling. If that happens offset using the directions described in **How To Offset a Transect**.

When entering data on the CF data forms, examiners may run out of space on the first page or sample more than 5 quadrats per transect. The first page allows only 5 quadrats per transect. If more quadrats per transect are sampled, use the CF continuation form. The form was designed to print one copy of the first page, and several copies of the second page. The second page of the data form allows the examiner to write the quadrat number on the form. This allows the examiner to design the form to accommodate the number of transects sampled. Print out enough pages to record all species on all transects for the required number of transects.